OPTICAL SHORT-CIRCUIT INSERT AND OPTICAL SHORT-CIRCUIT PLUG

Field of the Invention

The present invention relates to a short-circuit insert and a short-circuit plug, and more particularly to a short circuit apparatus for a diagnostics interface or a device place-holder in an optical database system.

Background of the Invention

Bus systems are increasingly used in place of wiring harnesses for connecting different components or devices, respectively in a motor vehicle. A plurality of components are typically coupled to one another in what is known as a ring bus. The individual components connected to one another in ring form exchange their data with one another via wire conductors or optical fibers. A diagnostics interface is provided in a typical ring bus to allow routine tests to be carried out, such as to check the functions of the components as well as to search for a defective component in an optical ring bus. During normal operation a bridging plug is inserted in this interface to bridge or short-circuit the interface and, thereby complete the ring of the ring bus. The bridging plug is removed for diagnostic purposes, making the diagnostics interface accessible for coupling to a diagnostic or test device.

Generic optical short-circuit plugs are described for example in DE 35 44 137 A1, in US 4,982,083 A and in US 5,076,688 A. An optical short-circuit plug provided in DE 44 28 855 A1 for short-circuiting two optical units contains a short-circuit optical fiber whose ends are each received by a contact pin for coupling to the optical units. The contact pins are provided as

separate elements and are enveloped in a sleeve of elastic material. The sleeve deforms during pin mounting to generate a defined application force and for tolerance compensation.

Finally an optical connector plug is provided by DE 199 51 257 A1 for bridging an open or non-assigned or interrupted plug connection in an optical bus system. The optical connector plug has a plug housing with a plug region by means of which the connector plug can be plugged onto the plug end. A groove is molded into the plug housing into which groove an optical fiber with attached fiber end sleeves is laid.

However, a need still exists for a compact optical short-circuit insert and a corresponding short-circuit plug. This object is achieved by the present invention, as will be described hereafter.

Summary

The diagnostics interface of an optical databus system is typically arranged within a ring structure. It has a device plug with two open optical fiber ends. These fiber ends are connected to a short-circuit plug for normal operation of the optical bus system according to an embodiment of the invention. The fiber ends are alternatively connected to a diagnostics plug of a diagnostic or test device for checking the optical databus system. The additional optical coupling position (diagnostics interface) for connecting a diagnostic or test device inside the optical ring structure allows rapid diagnosis of all components wired to one another in the ring structure and of the optical fiber of the ring structure itself, without requiring a component to be physically separated from the databus. In the operational state of the databus system (normal operation), the short-circuit plug is plugged-in to the optical coupling position to close the ring structure. The short-circuit plug is manually separable.

An examplary optical short-circuit plug, according to the invention, has an optical fiber portion curved through an arc of 180 degrees inside a plastic housing. The optical fiber is molded in an open U-shape with two legs running parallel to one another. It is important that the damping of the ring bus does not increase significantly when the short-circuit plug is introduced.

Depending on the structure of the optical ring bus, a multi-component glass may be suitable for the optical fiber. The multi-component glass is plastically deformed under the application of heat and formed into the desired 180-degree bend. Alternatively, a multicore glass fiber can be used which consists of a combined fiber bundle. It is important for the optical fiber to have cladding, (e.g., an external layer or external sheath consisting of a glass which has a lower refractive index than the core). For a multicore glass fiber, each individual fiber of the fiber bundle is provided with a sheath or a sheath layer. An optical fiber having glass with cladding requires a minimum bending radius of approximately 2 mm. The reflective properties within the optical fiber are impaired if the radii are smaller than this minimum bend radius. An optical short-circuit plug with a bending radius of less than 5 mm is relatively compact and can therefore be accommodated without problems in almost any desired position, for example in a motor vehicle.

Brief Description of the Drawings

The invention will now be described by way of example with reference to the accompanying figures of which:

Figure 1A shows a side view of a short-circuit insert according to an embodiment of the invention,

Figure 1B shows a plan view of the short-circuit insert of Figure 1A,

Figure 2 shows a perspective view of the short-circuit insert of Figures 1A and 1B,

Figure 3 is a sectional plan view of the short-circuit insert of Figures 1A, 1B, and 2 showing an optical fiber embedded in a carrier element of the short-circuit insert,

Figures 4 and 5 are a side view and plan view, respectively of a short-circuit plug with a short-circuit insert pushed into a housing enveloping a plug according to an embodiment of the invention,

Figure 6 shows a perspective view of the short-circuit insert pushed into the housing enveloping the plug,

Figure 7 is a perspective view of the short-circuit plug of Figures 4, 5, and 6 showing a latch insert for securing the short-circuit insert in the housing enveloping the plug,

Figures 8 to 10 are a side view, a plan view and a perspective view, respectively showing a short-circuit insert connected to an intermediate element, and

Figures 11 to 13 are a side view, a plan view and a perspective view, respectively showing a short-circuit insert pushed into an alternative housing enveloping a plug according to another embodiment of the invention.

Detailed Description

A short-circuit insert 2 according to an exemplary embodiment of the invention is shown in Figures 1 and 2. The short-circuit insert 2 has a rectangular head region 27 with two plug pillars 22 protruding out of it vertically to form a plug region 21. The plug pillars 22 each have a substantially cylindrical contour and taper from a diameter which is slightly smaller than a height of the head region 27 to a smaller diameter with respectively one or two raised latching rings 44, 45, wherein the first latching ring 44 provides a latching seat or shoulder 41 for latching the

short-circuit insert in a plug recess of a corresponding plug housing 4 as shown in Figure 4. Optical fiber ends 26 are positioned at the end faces of the plug pillars 22. Optical fiber ends 26 interact with corresponding counter-surfaces in the plug housing 4 to allow signal coupling or signal uncoupling respectively.

Primary securing of the short-circuit insert in the housing enveloping a plug 4 is provided by first latching ring 44 at the right-hand plug pillar 22 (shown in Figure 2), which latching ring 44 can easily latch into a corresponding groove in the receiving region of the corresponding housing enveloping a plug. Secondary securing comprises second latching rings 45 which are positioned at the same height on both plug pillars 22. The first latching ring 44 is provided for securing the short-circuit insert 2 against falling out of the plug housing 4, but does not prevent the short-circuit insert 2 being pulled out of the plug housing 4.

The short-circuit insert 2 is prevented from being pulled out by a secondary securing means. In Figures 4, 5, 6, 11, 12 and 13, the second latching rings 45 grip the plug housing 4 to provide secondary securing. In Figures 8, 9 and 10, grooves 28 provide secondary securing.

In an exemplary embodiment of the invention, as shown in Figures 4, 5, 6, 11, 12 and 13, secondary securing is provided by interaction between second latching rings 45 and a latch insert 46 (shown in Figures 4 and 6). Latch insert 46 is pushed into a receptacle 47 (shown in Figure 6) in the plug housing 4. When the short-circuit insert 2 is inserted into the plug housing 4, the latch insert 46 engages behind the second latching rings 45 to prevent pulling the short-circuit insert 2 out of the plug housing 4.

In an alternative exemplary embodiment of the invention, as shown in Figures 8, 9 and 10, secondary securing is provided by interaction between the grooves 28 and a metal spring 6

pushed over the plug housing 4. When the short-circuit insert 2 is pushed into the plug housing, the spring 6 engages with the grooves 28 to prevent short-circuit insert 2 from being pulled out of the plug housing 4.

Referring again to Figures 4 through 7, a short-circuit insert 2 is shown pushed into a plug housing 4. Secondary securing of the short-circuit insert 2 is provided by the latch insert 46 when it is pushed into the intended receptacle 47. Prior to fully pushing the latch insert 46 into the receptacle 47, the latch insert is slidingly aligned with the receptacle 47. In Figures 4 through 6, the latch insert is not fully pushed into the receptacle 47. In the fully pushed-in state, the latch insert 46 can dip into the receptacle 47 until flush with it.

The plug housing 4 of Figures 4 to 6 with the short-circuit insert 2 installed forms the counter-piece (i.e., substitute) to a diagnostics plug of a diagnostic device (not shown). For this purpose, the plug housing 4 has a plug recess. With the diagnostic plug (not shown) of a ring bus (not shown) plugged-in to the plug recess of the plug housing 4, a largely damping-free signal transmission is possible from the optical fiber ends 26 to the optical fiber ends (not shown) of the diagnostics plug.

Figure 3 shows the short-circuit insert 2 which has a curved optical fiber portion 23 inside a carrier element 29. This optical fiber portion 23 runs inside the plug pillars 22 in straight portions 25 respectively, which are joined by an arc portion 24 located inside the head region 27 of the plug insert 2. The arc portion 24 describes a bend of 180 degrees such that the optical fiber ends 26 of the straight portions 25 are disposed parallel to one another.

The carrier element 29 of the short-circuit insert 2 can, for example, consist of injection-molded plastic into which the optical fiber portion 23 is molded. Alternatively,, the carrier

element 29 can consist of two plastic housing halves which are bonded to one another or interlocked after insertion of the optical fiber portion 23.

The optical fiber portion 23 may, for example, consist of multi-component glass with cladding which previously was brought into the desired shape by means of heat, so that it is held free of stress in the carrier element 29. Alternatively, a multi-conductor glass fiber (what is known as a multicore glass fiber) can be formed into the optical fiber portion 23. The multi-conductor glass comprises a large number of fine single fibers being mechanically combined to form a fiber bundle. Which of these embodiments of the fiber portion 23 is used depends upon the desired application (i.e., the structure of the ring bus being short-circuited. The cladding serves to produce different refractive indices between the core and the sheath of the optical fiber so as to reduce the damping of transmitted signals due to undesired uncouplings.

The dimensions of optical fiber portion 23 must provide optical coupling without significantly increasing damping. It is highly desirable to provide a small envelope to accommodate various applications in which space is limited. The inventors have determined that these goals can be achieved by controlling certain dimensions in the short-circuit insert 2. In an exemplary embodiment, the thickness of the optical fiber is about 1 mm, and the center distance between the optical fiber ends 26 is about. 6 mm. The total length of the short-circuit insert 2 is about 25 mm with the head region 27 having a length and width, each of about. 5 mm. A typical diameter of the plug pillars 22 in the lower plug region 21 is about 3 mm. In the upper region, the plug pillars 22 can have a diameter approximately equivalent to the width of the head region 27 (approx. 5 mm). The resultant bending radius of the arc portion 24 of the optical fiber portion 23 in the head region 27 is a dimension of about 3 mm. With this bending radius, no significant signal damping will occur due to uncoupled light.

A preferred refractive index of the cladding glass is about 1.6. A preferred refractive index of the core glass is about 1.5. The diameters of the single fibers in a multicore optical fiber are preferably between about 30 and 70 μm and more preferably about 50 μm. The thickness of the cladding is preferably about. 3 μm. Signal damping in an optical fiber curved through 180 degrees which is built into a plug according to the invention is preferably less than 4 dB.

An alternative connection of the short-circuit insert 2 with a plug housing 4 is illustrated by reference to Figures 8 through 10. Such a connection is primarily intended for making a connection between conductors. An intermediate element can be pushed into the plug housing 4, in which intermediate element corresponding optical fiber ends (not shown) are embedded. These fiber ends are optically connected to the optical end surfaces 28 of the short-circuit insert 2.

Figures 11 to 13 show an inserted short-circuit insert 2 in an alternative embodiment of plug housing 4. The plug side here is capable of connection to a female connector and serves as a device place-holder. In this embodiment, the secondary securing is provided by the latch insert 46 which is insertable into the receptacle 47. The plug housing 4 shown in these figures is preferably intended for recessed mounting.